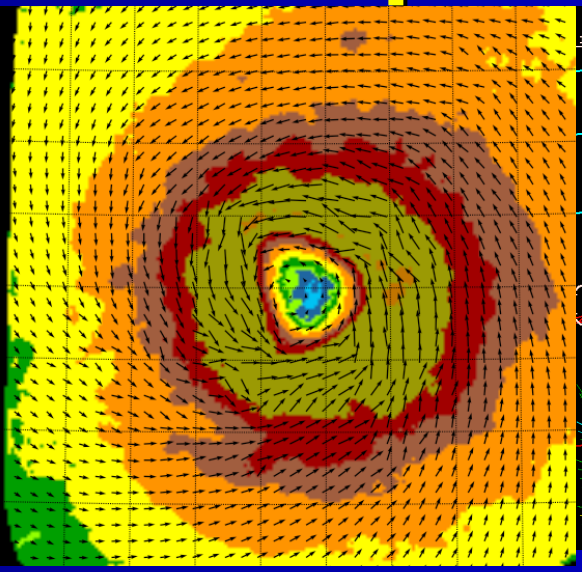
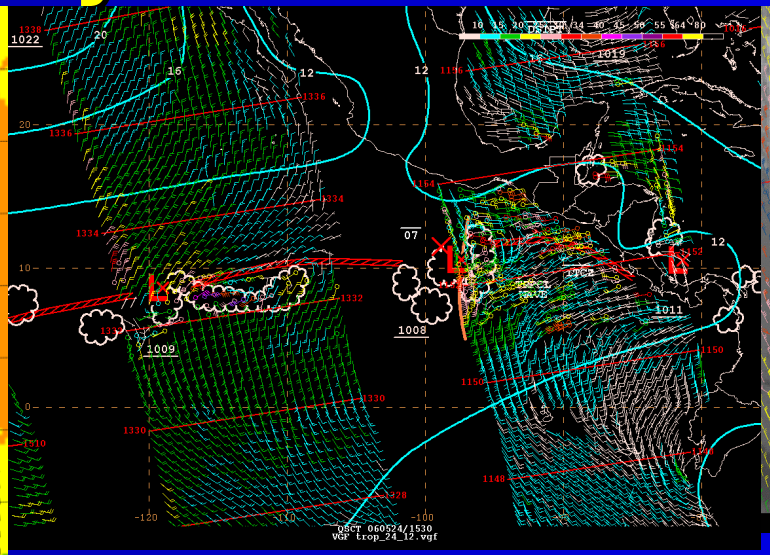
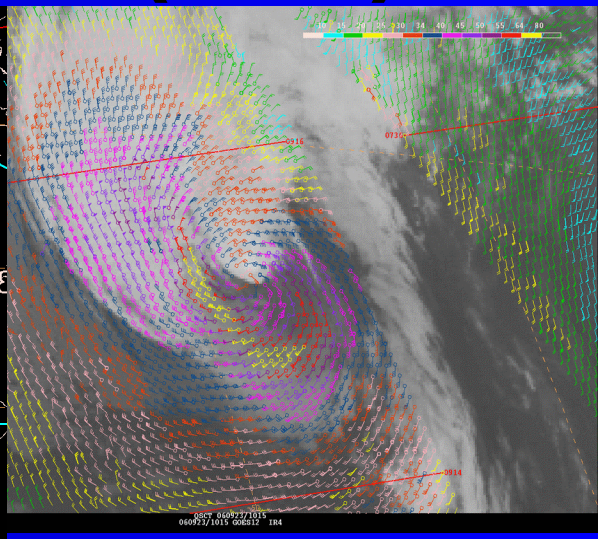
Moving Toward an Operational Satellite Ocean Surface Vector Winds Capability with a Dual Frequency Scatterometer (DFS)







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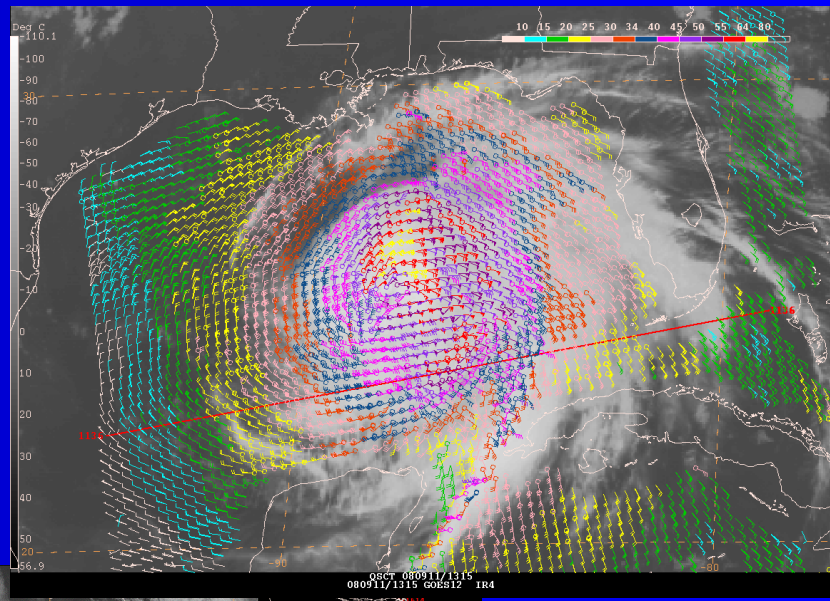
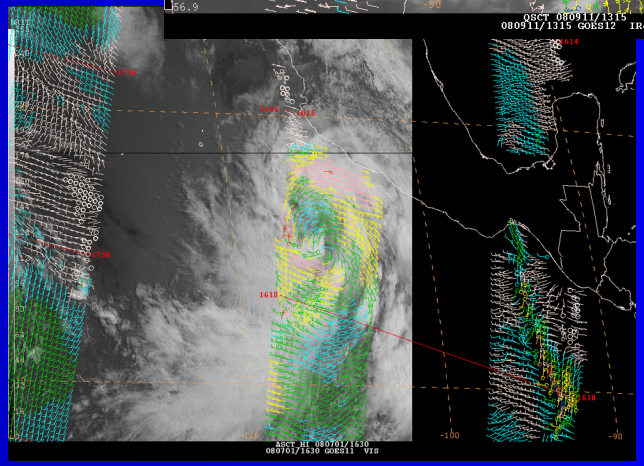
[3]NOAA/NWS Central Pacific Hurricane Center, [4]NOAA/NWS/NCEP Ocean Prediction Center

Ocean Vector Winds in NWS Operations

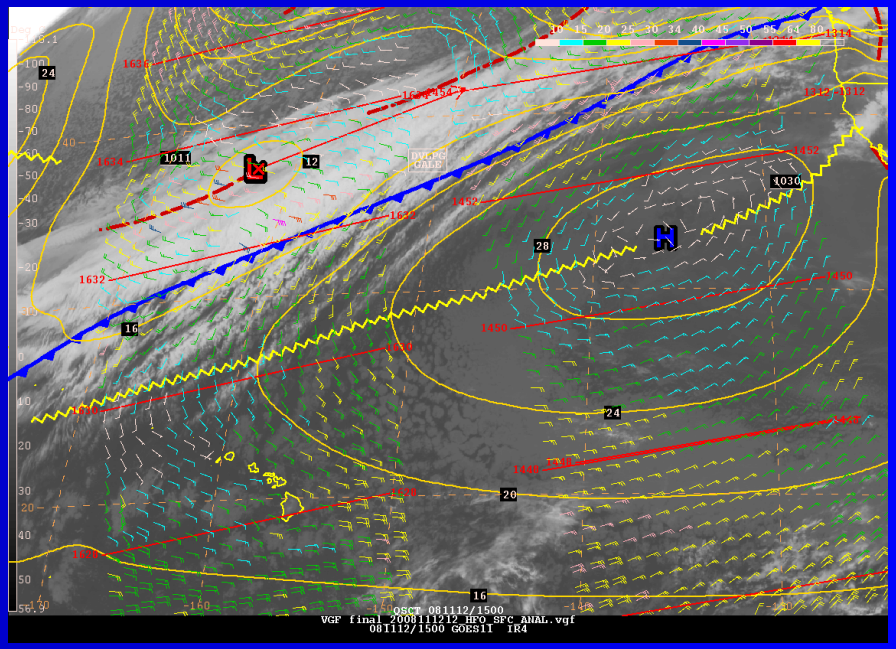
- Satellite ocean vector winds are an important tool for marine and tropical cyclone (TC) analysis and forecasting
  - Useful for analysis of TC intensity, location, and structure – however limited by resolution and rain contamination





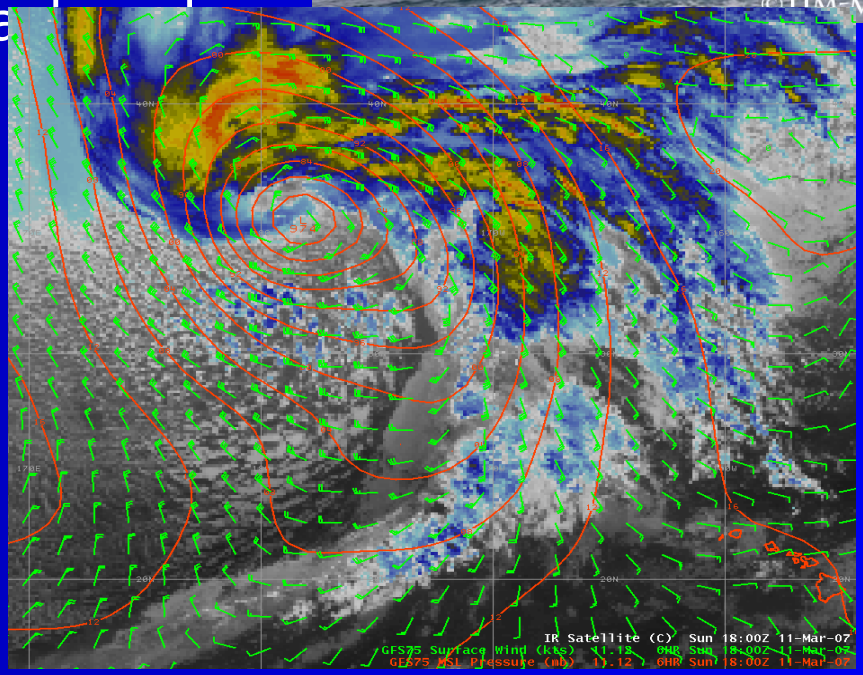
Ocean Vector Winds in NWS Operations

- Satellite ocean vector winds are an important tool for marine and tropical cyclone (TC) analysis and forecasting
  - Critical for detection of and warning for hurricane-force extratropical cyclones



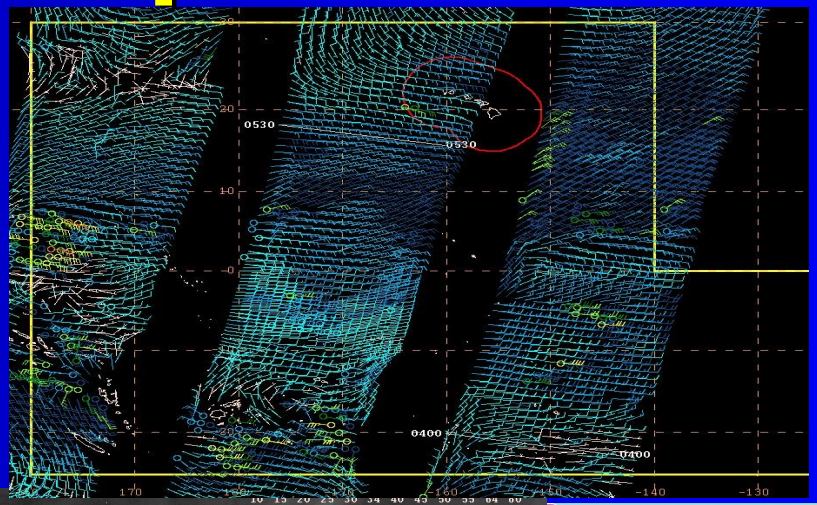
Ocean Vector Winds in NWS Operations

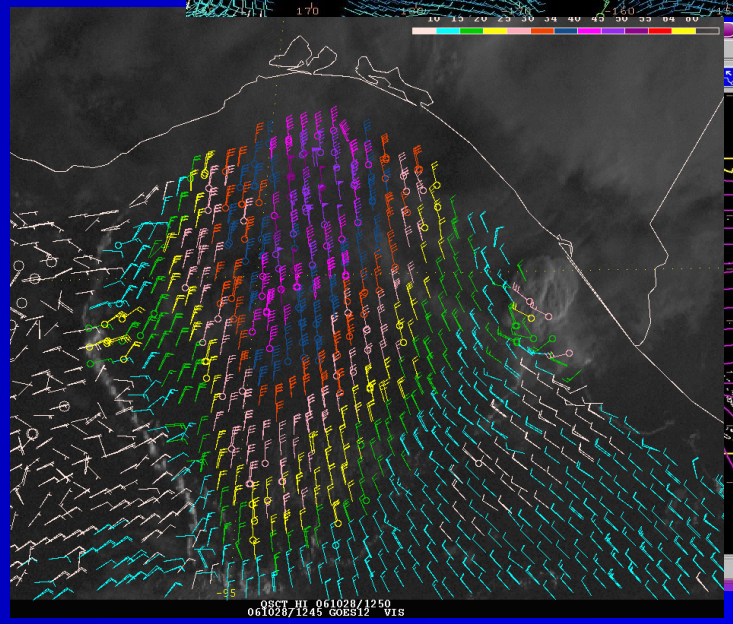
- Satellite ocean vector winds are an important tool for marine and tropical cyclone (TC) analysis and forecasting
  - Used to determine regions of swell generation – limited for coastal and near shore applications by land ma[illegible] resolution

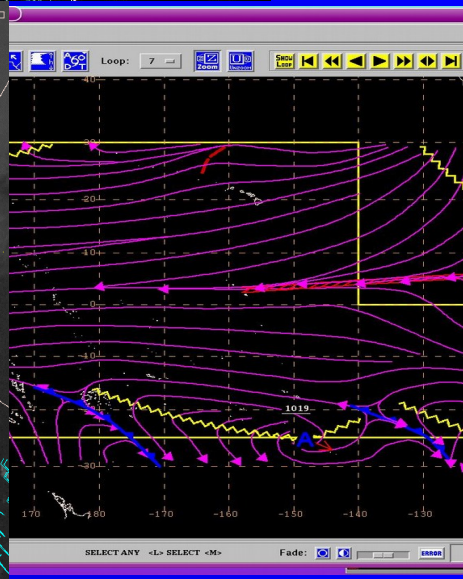


QuikSCAT Impacts on Analysis and Forecasting in the Tropics

- More accurate analysis of key synoptic features at the surface
- Introduction of new features depicted on surface analysis
- Greatly improved detection, forecasts, and warnings of high impact events
- Improved verification
- Construction of climatologies







Where We Are Now

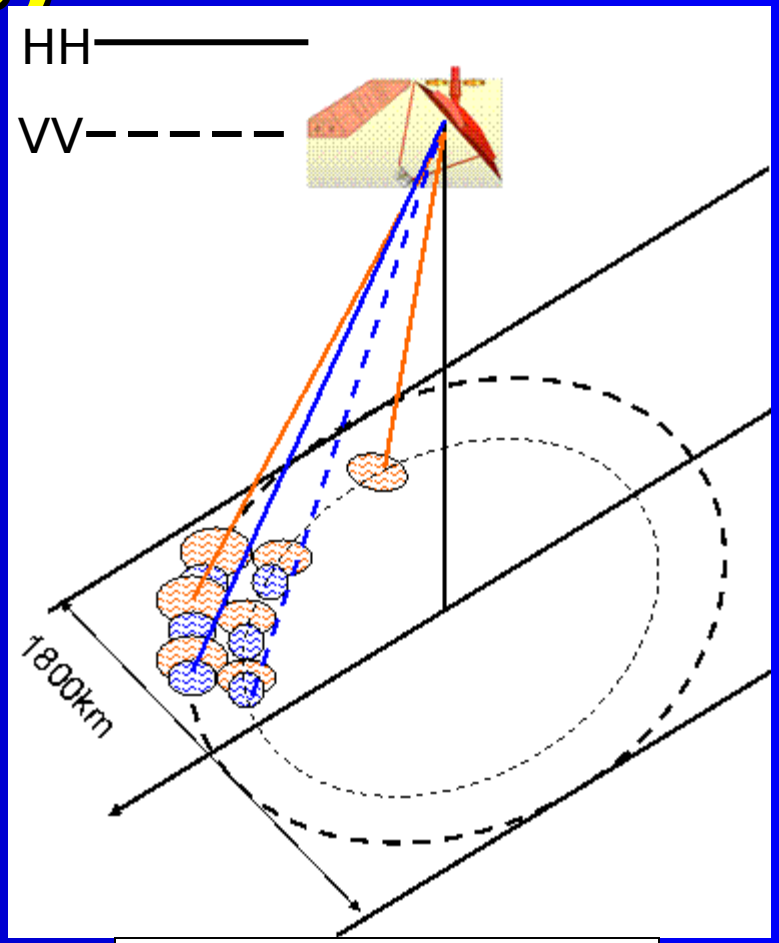
- QuikSCAT aging rapidly
  - Multiple failures have pressed backup systems into operation
  - Several single points of failure now exist
    - Science telemetry transmitter, spare battery, power control unit
- ASCAT data available and used in NWS operations
  - Retrievals have reduced coverage and resolution compared to QuikSCAT
  - While less sensitive to rain, ASCAT shows low bias at high wind speeds compared to QuikSCAT
- NOAA still searching for long-term operational ocean vector winds solution
  - XOVWM deemed too costly as stand-alone mission

NOAA/NASA/JAXA Partnership

- Japanese Space Agency (JAXA) planning GCOM-Carbon cycle (GCOM-C) and GCOM-Water cycle (GCOM-W) series to succeed ADEOS and Aqua missions
  - 13-year mission; three satellites in series, each with 5-year lifetime, 1-year overlap with follow-on satellites for calibration
  - GCOM-W1 planned for launch in 2012, GCOM-W2 2016
- Since June 2008 NOAA, NASA/JPL, and JAXA have been discussing potential partnership
  - U.S. would provide scatterometer on GCOM-W2 mission
- Three meetings held between NOAA-JPL-JAXA
  - 1st meeting: JAXA specified spacecraft constraints within which GCOM-W scatterometer should be designed
  - 2nd meeting: DFS accepted as a baseline for GCOM-W2
  - 3rd meeting: Joint Science Team and Research and Operational Users Working Group (ROUWG)

Dual Frequency Scatterometer (DFS)

- Dual Frequency (Ku and C-band) Scatterometer (DFS) being designed by NASA/JPL
  - Ku-band (H-pol and V-pol)
  - C band (H-pol) (mitigates rain contamination)
  - 1.8 to 2-m antenna → basic resolution ~ 10 km (compared to 25 km for QuikSCAT)
  - 1800-km wide swath (identical to QuikSCAT)
  - AMSR onboard with DFS provides opportunity to improve surface products from both
  - Instrument design constrained by GCOM-W2 and AMSR instrument designs



Slice resolution
16km x 3km
25-34km x 3km

DFS Design and Capabilities

- C-band channel necessary to improve retrieval quality in rain
  - C-band measurements much less affected by rain
  - DFS will have H-pol C-band channel at both incidence angles
- Experience with ASCAT and DFS simulations show that adding C-band channel will yield substantial improvements over QuikSCAT retrievals in rain

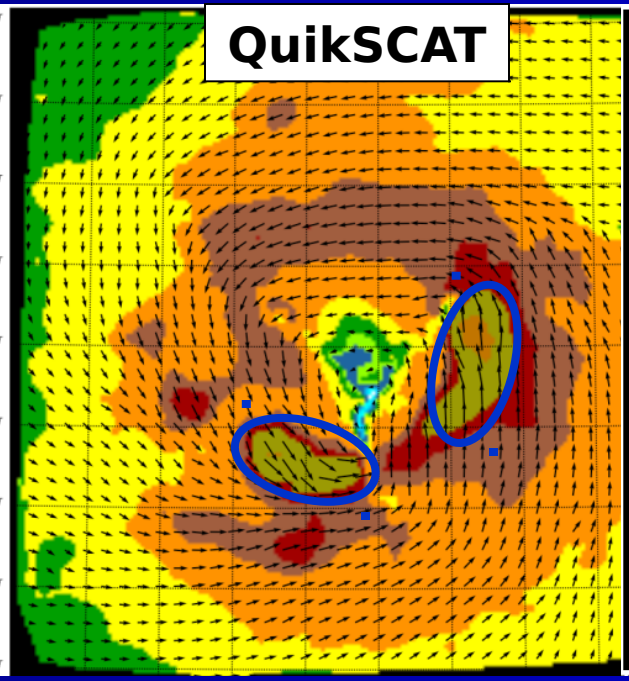
DFS has capability to provide accurate retrievals in nearly all weather conditions, including category 1 and 2 hurricanes

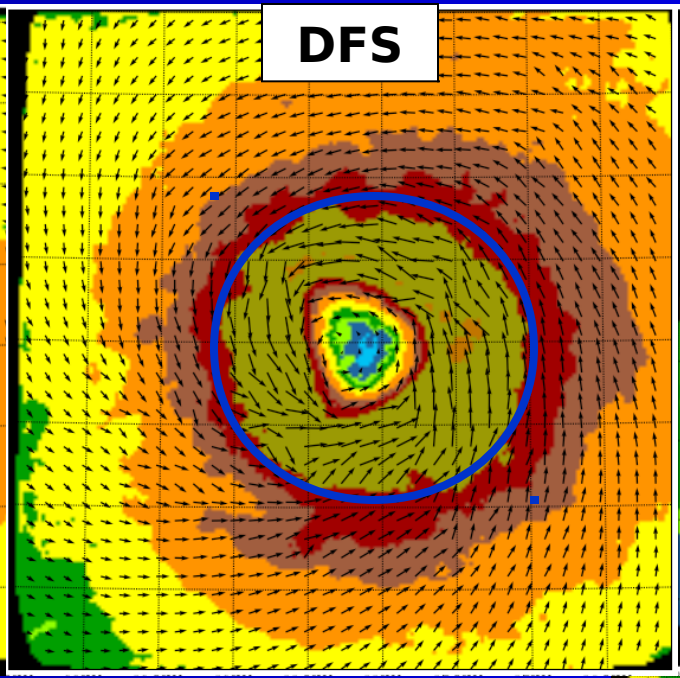
DFS Expected Performance

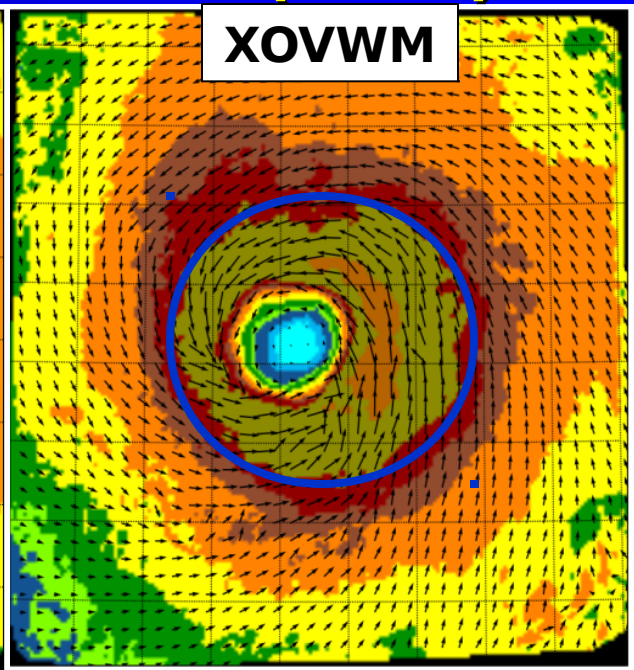
- Basic resolution of DFS is ~10 km compared to ~25 km for QuikSCAT
- DFS will improve wind retrieval accuracy over QuikSCAT by at least 20%
  - Increased power, number of looks, frequency diversity, larger aperture size
- At high wind speeds, DFS can improve accuracy up to 50%
  - Small-scale wind maxima in TCs still cannot be resolved, but rain contamination mitigated
- No significant improvement in the distance to the coast achievable between QuikSCAT and DFS

DFS vs. QuikSCAT and XOVWM

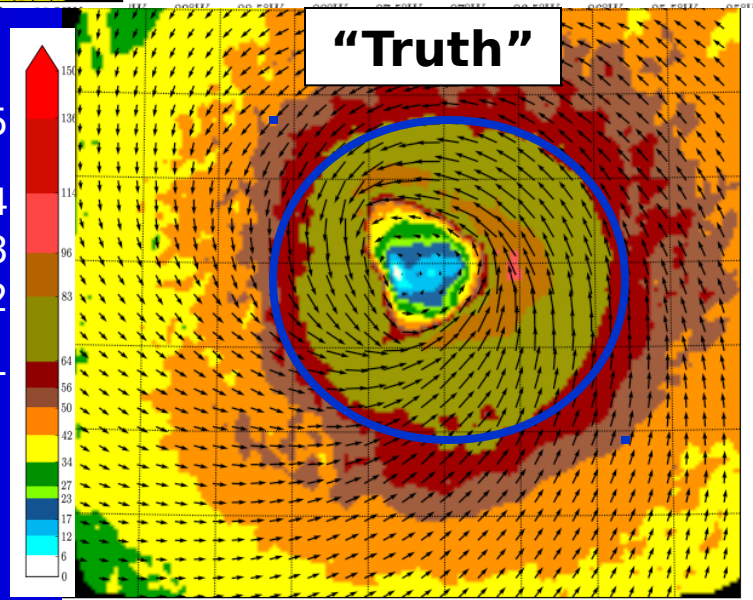
Simulated Retrievals based on Katrina (2005)







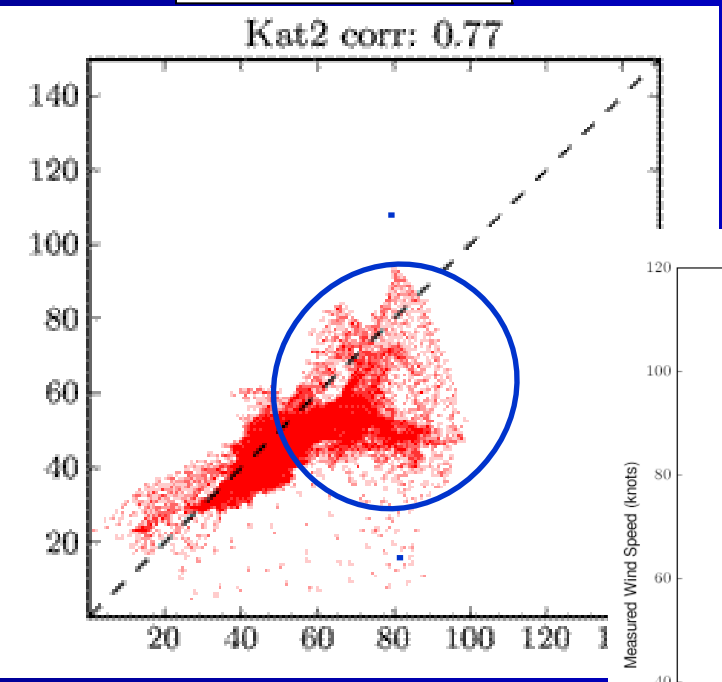
- DFS captures true wind signal where QuikSCAT high winds are tied to rain
- DFS accurately depicts hurricane force wind radii and retrieves winds into category 2 range, but not into cat 3 range
- DFS cannot identify small scale



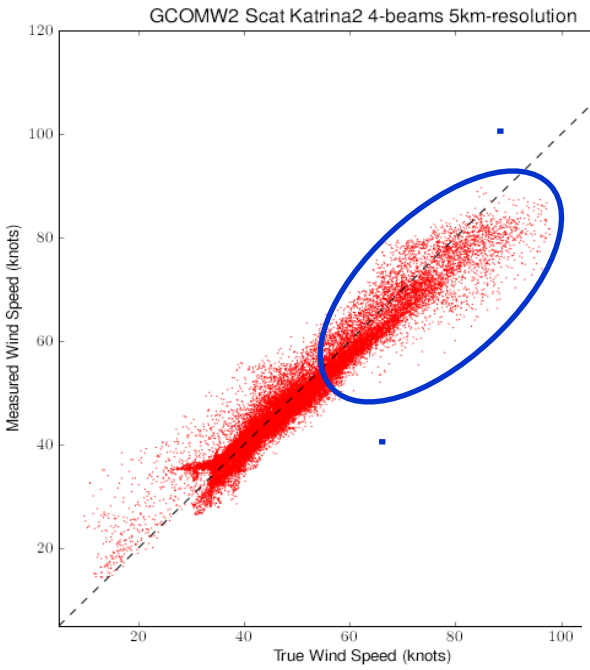
DFS vs. QuikSCAT and XOVWM

Katrina Simulated Retrievals

QuikSCAT

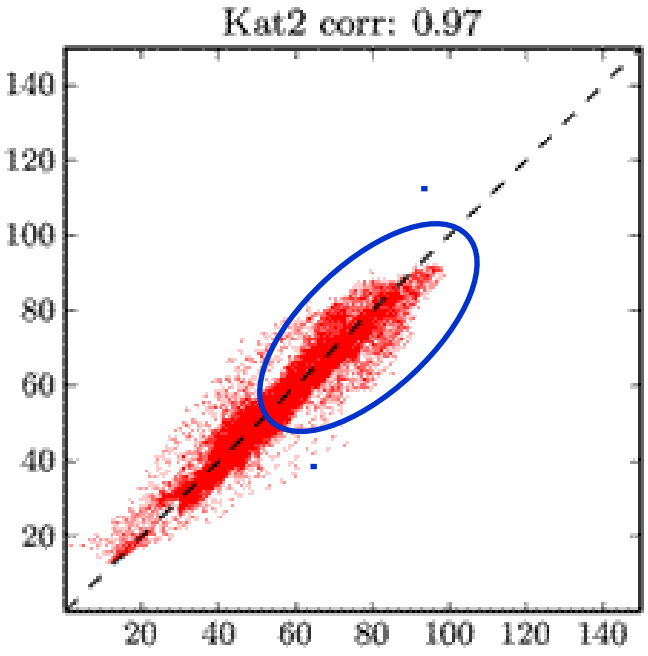


DFS



- DFS captures true wind signal well into hurricane-force range
- DFS shows underestimation of winds ≥ 80-85 kt (not seen in XOVWM)
- Significant improvement over QuikSCAT

XOVWM

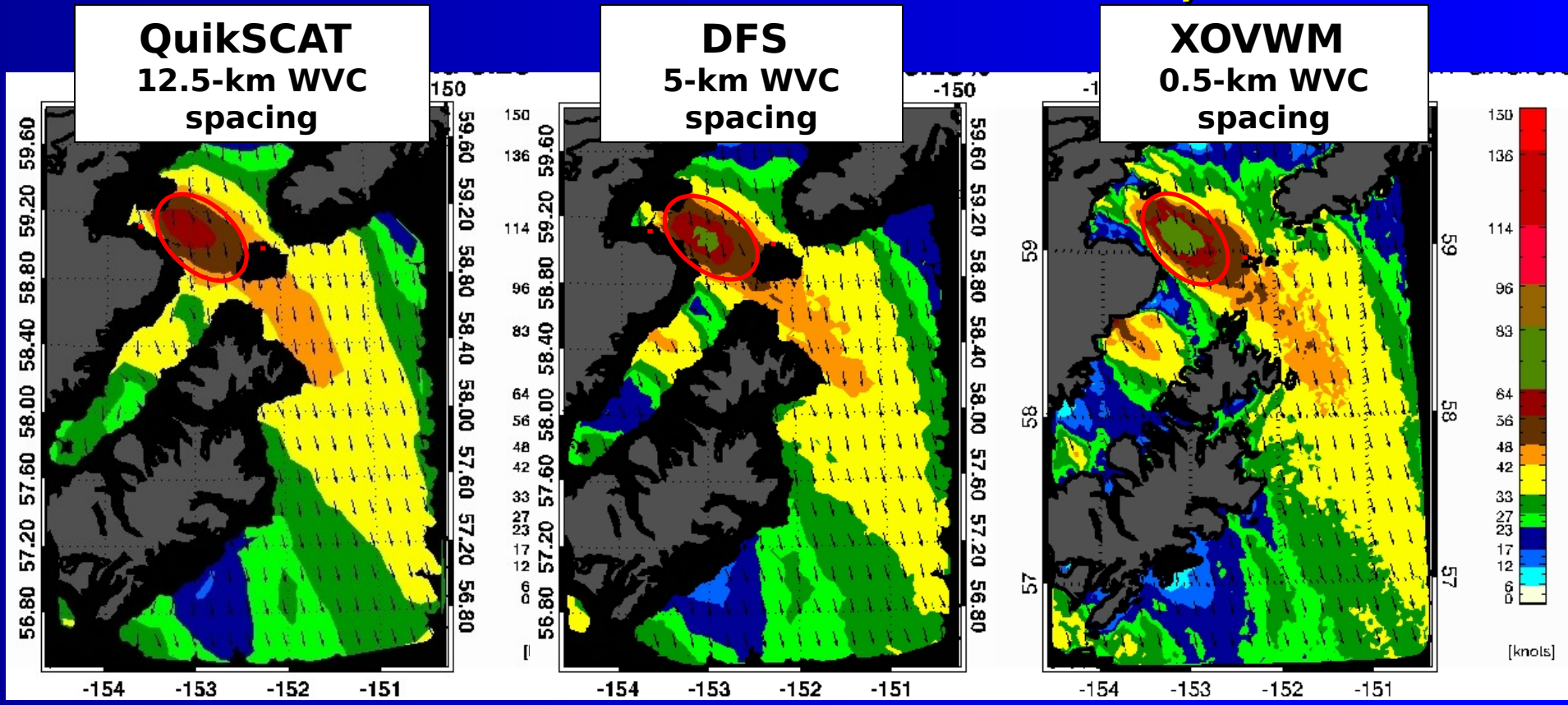


Retrieved Wind Speed

"True" Wind from WRF simulations

DFS vs. QuikSCAT and XOVWM

Coastal Retrievals – Shelikof Strait, Alaska



- DFS provides retrievals slightly closer to the coast compared to QuikSCAT
- Work underway that could provide retrievals from QuikSCAT and DFS within 6 km of the coast
- Does not show large improvement seen in coastal XOVWM retrievals
- Higher resolution DFS captures smaller-scale wind features not seen by QuikSCAT

Statements of DFS Impact
Tropical Cyclones

- Identification of well-defined surface circulation to determine TC formation
  - Begin watch/warning/advisory process earlier, especially when no aircraft recon available (eastern Atlantic, most Eastern and Central Pacific TCs)
- Better estimate of initial motion
  - Important for subjective analysis, forecasts, and initiation of model guidance
- Directional ambiguity issue less of a factor
  - More confidence in automated solution
  - No more manual ambiguity analysis?

Statements of DFS Impact
Tropical Cyclones (continued)

- Accurate estimates of TC intensity from tropical depression to category 2 hurricanes
  - Differentiate tropical depressions from tropical storms and tropical storms from hurricanes with greater certainty, particularly where/when aircraft reconnaissance not available
- More accurate analysis of 34-kt, 50-kt, and 64-kt wind radii in all TCs
  - Critical to placement and timing of coastal watches and warnings and definition of ship avoidance areas
- Can provide important information on TC climatology, especially in basins with no aircraft recon

Statement of DFS Impact
Marine

- Improved wind field structure across broad spectrum of marine weather phenomena, including extratropical cyclones, subtropical cyclones, tropical waves, fronts, squall lines, areas of convection, and the ITCZ
  - Retrievals from QuikSCAT often degraded by heavy rainfall in these systems
- More accurate and higher resolution retrievals in most weather conditions will improve quality of warnings
- Better analysis of 34-kt, 48-kt, and 64-kt wind areas in extratropical cyclones
- Improved identification of wave and swell generation areas – benefits coastal high surf forecasts/warnings

DFS Timeline

- Pre-phase A funding for concept development would continue through **September 2009**
- JAXA GCOM-W mission definition review (**December 2009**) is important step in JAXA budget approval process
- Phase A project formulation activities need to begin **early in FY10**
- DFS interface requirements must be defined in advance of the JAXA GCOM-W spacecraft contractor source selection (**July 2010**)
- Phase B preliminary design activities early in FY11 (**October 2010**) to meet DFS flight instrument need date in **May 2014** for a **January 2016** GCOM-W2 launch date

NOAA Budget Status

- JAXA Partnership included in FY 11-15 NOAA program decisions for Ecosystem, Climate, W&W, C&T, and Satellite goals

- NOAA/NWS needs to support active participation in JAXA/NOAA Research and Operational Users Working Group (ROUWG) to ensure best operational capability